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Is there a difference between teacher perceptions about computer lab use in developing higher order thinking skills and actual computer lab practices?

Eduardo David Gonzalez

IS THERE A DIFFERENCE BETWEEN TEACHER PERCEPTIONS ABOUT COMPUTER LAB USE IN DEVELOPING HIGHER ORDER THINKING SKILLS AND ACTUAL COMPUTER LAB PRACTICES?

A Thesis
Presented to the
Faculty of
California State University,
San Bernardino

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
in
Education:
Instructional Technology

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Eduardo David Gonzalez
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ABSTRACT

This descriptive research study sought to find if a difference existed between the perceptions of teachers using the computer lab as a tool in developing higher order level thinking skills and actual computer lab practices. The study surveyed 15 teachers from an elementary school in Southern California regarding their computer lab perceptions, and the results were compared with their actual computer lab activities. Data regarding actual computer lab practices was collected over a period of one school year. This data was analyzed and categorized by using Bloom's Taxonomy descriptors. Each computer lab activity was scaled and given a value using these descriptors of higher order thinking skills. The results of the data indicated that a difference did exist between these two areas.

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To my parents,

for every kilometer

of the journey.

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CHAPTER ONE

INTRODUCTION

Purpose and Overview

The purpose of this descriptive study was to investigate if a difference existed between the perceptions of teachers regarding the use of the computer lab in developing higher order thinking skills and their actual computer lab practices. In other words, teachers were asked specific questions about what they thought regarding their computer lab activities. These were compared to their actual lab activities. Some of the questions were geared specifically to address their perceptions about using the computer lab as a tool in developing higher order thinking skills.

Before collecting and examining any data, an effort was made to choose an existing thinking model to analyze and encode the computer lab activities. From the many existing thinking models, Bloom's Taxonomy of Cognitive Domain was chosen for its stratification of thinking levels (Bloom, 1956). Bloom outlines the six major levels of cognitive thought and provides descriptors, or action verbs, for each level (Appendix A). The use of this model simplified the encoding process of the actual computer lab activities.

The perceptions of teachers were collected through the use of a survey. In the study, particular attention was placed on the gathering of data over an entire school year. Upon careful study of the various lab activities used by the teachers, each computer lab activity was encoded with a numeric value corresponding to one of the six thinking levels from Bloom's Taxonomy. Thus, a higher numeric value given to a computer lab activity corresponded to a level of higher order thinking.

After the collection and encoding of the data, the information gathered was sorted and analyzed. The results of the teacher surveys were compared with the actual encoded computer lab activities and used to answer the research question. In the research question it was noted that a difference existed between teacher perceptions regarding the use of the computer lab as a tool in developing higher order thinking skills and their actual computer lab practices. In the research question, effort was made to only see if a difference was notable and did not point to a particular direction, i.e. whether a gap between the two areas existed or not.

Goals

Aside from answering the research question, this study involved many goals. One of the main goals was to allow for a long period of time to collect data. A period of one year provided an overall insight to how a computer lab is used in the elementary school setting. A shorter period of time, such as one or two months, would have limited the type of information gathered, since activities varied from the beginning, middle, and end of the school year. Thus, it was imperative to allow sufficient time to collect adequate data.

Another goal was to encode the data in order to allow comparison of the results between the perceptions of teachers and the actual computer lab activities utilized. This was made possible through the use of a scaled survey to measure the teachers' perceptions. Bloom's Taxonomy of thinking levels was utilized to encode a numeric value to the various computer lab activities. As a result, the comparison of these two variables was made possible in order to answer the research question.

With the results of this descriptive study, a correlation between the two variables could be plotted and further analyzed. Based upon the results, special recommendations could be made to bridge gaps between the perceptions of teachers and the actual computer lab practices. Further efforts, such as curriculum design and enhanced computer lab methodology, could serve to provide teachers with the necessary means to use the computer lab as a tool in helping develop higher order thinking skills.

Limitations

Although the time factor of the study was adequate, there were some limitations. Over the entire school year of study, a total of 1,320 computer lab activities were recorded. These activities could be separated into several categories ranging from data entry, simulations, drill and practice, internet research, test preparation, reading skills, and long-term computer projects. While there were many activities, most activities tended to fall under these general categories, which were later encoded with Bloom's levels of thinking. After careful review of each activity, it was assigned a numeric value, from one to six, that corresponded to one of the six levels of thinking from Bloom's Taxonomy.

Nevertheless, some activities were difficult to categorize and consequently encode. Some computer lab activities contained descriptors for two levels of thinking. In instances like this, the activity was classified according to the greater number of descriptors of one particular thinking level that it contained. In other words, if an activity had descriptors from two levels of thinking but was more characteristic of one particular level, then that level of thinking was assigned to that activity.

Moreover, this study only investigated the computer lab activities that each teacher assigned and performed during the course of a school year. This study did not look at the individual works of students, but rather only recorded the lab activities that were assigned as a whole group. Consequently, some teachers would assign up to four activities during their computer lab time, and thus, those activities would be recorded. This is not to say that all students completed all the activities during that time, but only that those activities were assigned during that lab session. While some students may have very well completed all of the activities, others may have only partially completed the tasks. It was not a goal of this study to look at individual student results.

List of Terms

Bloom's Taxonomy - a model of thinking stratified into six levels of cognition (Bloom, 1956)

Knowledge - the first level in Bloom's Taxonomy in which learned material is simply recalled (Bloom, 1956)

Comprehension - the second level in Bloom's Taxonomy in which comprehension of a subject is attained (Bloom, 1956)

Application - the third level in Bloom's Taxonomy in which newly acquired information is applied in a new way (Bloom, 1956)

Analysis - the fourth level in Bloom's Taxonomy in which newly acquired concepts are further broken down and understood (Bloom, 1956)

Synthesis - the fifth level in Bloom's Taxonomy referring to the ability to use place a concept back together into something new (Bloom, 1956)

Evaluation - the sixth level in Bloom's Taxonomy referring to the ability to judge and interpret one's own findings (Bloom, 1956)

Descriptors - action verbs describing a particular level of thinking

Higher levels - refers to Bloom's Taxonomy levels four through six

Lower levels - refers to Bloom's Taxonomy first three levels of cognition

CHAPTER TWO

LITERATURE REVIEW

Introduction

The subject of this literature review addresses how technology can serve as a tool to aid students in developing higher order thinking skills. This is not to say by any means that technology in it of itself will increase higher order thinking, but rather to facilitate its development. Before delving into the research and reviewing examples of practices related to this matter, it is important to define and explain what higher order level thinking skills entail. Higher order thinking has been, for the most part, defined in various ways, and thus, has lost the cohesiveness of its meaning. There are many thinking skills models that attempt to quantify and qualify higher order thinking skills. According to Beyer (1988), higher order level thinking skills consist of various descriptors. Among them, he notes distinguishing between verifiable facts and value claims, relevant and irrelevant information, identifying ambiguous claims or arguments, unstated assumptions, and logical fallacies (1988). According to Beyer (1988), students can employ several of these operations simultaneously.

Among the many other thinking skills models, such as Piaget's assimilation, accommodation, and adaptation model, and Renzulli's type model, Bloom's Taxonomy is a practical and useful framework that can be used to identify higher level thinking skills (Whittington, 2000). Bloom identified six levels of thinking, which begin from the lowest level of thinking, labeled as knowledge, to the higher levels of thinking, labeled as analysis, synthesis, and evaluation (Bloom, 1956). Furthermore, Bloom provided several action verbs to serve as descriptors of each thinking level. This is a useful tool to better aid teachers in identifying each level of thinking as they conduct their lessons using technology.

In using thinking models as a guide, such as Bloom's Taxonomy, a review of several classroom practices attempting to correlate the use of technology and higher order thinking skills will be analyzed. The purposes of this thesis will center on how technology aids students in developing higher order thinking skills.

Higher Order Thinking

Classroom teachers, while being asked to teach the basic skills, are constantly pushed to incorporate higher order thinking skills into their teaching practices (Young, 1992). At the same time, many high school students are not prepared for college work because they lack sufficient development in higher order thinking skills (Williams, 1994). This gap of preparedness must be curved to ensure that students have the proper skills to achieve success. While there is a great need for teachers to provide their students with opportunities to develop higher order thinking skills, the term of higher order thinking has not been properly defined over the years (Cuban, 1984).

The term higher order thinking has been misinterpreted with other terms, such as critical thinking and problem solving (Lewis et al., 1993). Though both of these terms are not mutually exclusive to higher order thinking, critical thinking and problem solving are only components to higher order thinking. At the same time, a distinction must be made between higher and lower order thinking. According to Newman (1990), lower level thinking "demands only routine or mechanical application" of prior knowledge. Nevertheless, activities that can appear to be higher order thinking for some may in fact be lower level thinking to others (Lewis et al., 1993). This depends on whether the student was merely recalling previously acquired knowledge, or actually reformulating knowledge to make new connections.

Higher level thinking can be distinguished because it contains specific elements. According to Bloom (1956), higher order thinking occurs when the levels of analysis, synthesis, and evaluation are attained. Furthermore, the lower levels are defined as knowledge, comprehension, and application (1956). Bloom uses descriptors, or action verbs, that directly identify each thinking level (Appendix A). For example, the thinking level of analysis may include descriptors, or action verbs, such as differentiates, distinguishes, infers, subdivides, and/or relates (1956).

Thus, an important part of higher order thinking is not just having knowledge, but knowing how to reshape it to solve or act on something new (Costa et al., 2000). Higher order thinking should not be taught as a separate entity of study, but rather through continuous application to real world situations (Stratton, 1992). Higher order thinking does not equate to problem solving because it does not involve creative thought (Lewis et al., 1993). According to Lewis and Smith (1993), higher order thinking can be defined:

> …when a person takes new information and information stored in memory and interrelates and/or rearranges and extends this information to achieve a purpose or find possible answers in perplexing situations.

Moreover, higher order thinking is defined as "the ability to think critically, make ethically and intellectually defensive decisions, and reason" (Thomas, 1987).

While defining higher order thinking is an important step, there are several implications for the classroom teacher. Higher order thinking skills must be taught and developed. These skills are not just for the highly talented or gifted students, but rather for every student (Lewis et al., 1993). Higher and lower level thinking skills should not be taught separately, but should be "interwoven" (1993). While basic skills are a necessary part of a student's education, higher order thinking skills are equally as essential. Thus, teachers should provide students with a well-balanced education that addresses both higher and lower order thinking. In the following section, several research studies dealing with the use of technology to aid the development of higher order thinking will be reviewed.

Review of Research and Practices Regarding Technology and Higher Order Thinking

Rawitsch (1988), from the University of Minnesota, conducted a study to examine the use of database programs to facilitate higher order thinking skills. In his methodology, he used 158 seventh grade students from a suburban junior high school. The length of the study spanned six days. Furthermore, this study divided the pool group into three treatment groups: 1) using only a simulation program, 2) using a database program with debriefing before the post-test, and 3) using the database with debriefing after the post-test. The post-test consisted of 24 reasoning problems from the pre-test and 30 new hypothetical-deductive reasoning problems. In the study's conclusion, no significant gain was made in the first two treatment groups. On the other hand, some significant gain was made in the group that used the database program with proper debriefing.

The researcher of this study attempted to quantify gains by students in higher order thinking skills and reasoning skills through the use of a database program. Though some gains were noted in the group that used the database with debriefing, the research study lacked several elements. First, the study itself consisted of only a few days, which were not spread out over a period of time to allow for the solidification of concepts. The researcher did not fully explain and describe the actual database program being used. Also, no mention was given as to how the students interacted with the technology to arrive at solutions for the problems. This would have been beneficial in order to pinpoint the thinking model descriptors to identify if higher order thinking skills were actually taking place. Furthermore, this study was lacking the observational component necessary to identify several higher order thinking skill descriptors.

Educators should always keep in mind and identify the descriptors of the thinking skills model when using technology to facilitate the development of higher order thinking skills. Sarapuu et al.(1999) emphasize several descriptors from Bloom's Taxonomy in their teaching practices relating to the use of technology. For example, Sarapuu et al. (1999) conducted a research study in nine middle and high schools in Estonia. The main purpose of the study was to find a correlation between the use of educational web pages to facilitate the development of students' higher order level thinking skills.

The research pool consisted of 86 students, 27 of which were from the middle school level and 59 from the high school level. Each 45 minute lesson consisted of a three-step approach geared to lead to higher levels of thinking, such as analysis and synthesis. The students accessed two educational web pages dealing with Estonian vertebrates and plants. The critical analysis component of the study was for students to create tables and charts to divide and classify several species of vertebrates and plants into groups. Students would then analyze the information to derive at various conclusions relating to other environmental issues.

The findings concluded that the use of technology did aid in helping students develop higher level thinking skills, but also concluded that, in general, students lacked the critical skills needed to accomplish the tasks that called for synthesis and evaluation. According to Sarapuu et al. (1999) this was due to the lack of exposure to the development of these types of thinking skills. Thus, the researchers went on to recommend that students would benefit substantially from continued efforts to develop lessons that help build higher level thinking skills.

The results of this study, though limited in scope and time, call for the continued emphasis for teachers to provide lessons that help students develop higher order thinking skills. Through the use of educational web pages and proper scaffolding, Sarapuu et al. (1999) were able to provide students this opportunity to expose and develop these skills. Almost 80 percent of the high school students were able to achieve the descriptors of analysis and synthesis, while only 31 percent for their middle school counterparts did. This study clearly defines the purpose of technology in education. In other words, the purpose is not for technology to replace education itself, but rather to serve as a tool to aid in learning, especially higher order thinking skills.

This is true for all subjects across the curriculum. The uses of technology are not limited to a particular subject area, but rather are integral to all subject matters. In the next article, Niess combined mathematics and science with the use of technology to aid students in developing higher order thinking skills. The study, which stemmed from funds diverted from TOMTOMS (The Oregon Mathematics Teachers of Middle School), called for the empowering of students to make mathematical connections to the real world (Niess, 1993). It focused, in particular, on the study and investigation of Oregon's weather.

Through this investigation, students were exposed not only to interpreting data, but also analyzing and synthesizing the information to draw conclusions. Using computer software similar to those used by meteorologists, students first obtained data relating to temperature, precipitation, and snowfall of Oregon. Additional information regarding geographical patterns and climate history was also obtained. The students conducted investigations by formulating comparison tables and graphs of various weather patterns of unidentified towns. Through their investigations, students were able to condense the data to make reliable predictions about the identity of the town.

Through this activity, students were able to analyze and synthesize data that pertained to the real world. These processes are clearly higher level descriptors of Bloom's Taxonomy. Like Sarapuu et al. (1988), Niess (1993) provides another clear example of how technology serves as a tool to aid students in the development of higher order thinking skills. However, although Niess (1993) supplied much information regarding the process of developing higher order thinking skills, very little mention was given to results. Niess (1993) did not provide for a means of assessing the students' learning.

The assessment component is a critical part for teachers to find out about the progress of their students in developing higher order level thinking. Manoucheheri (1997) explores number structures by using spreadsheets. The main goal of her study was to build higher order thinking skills with the aid of a spreadsheet program. The lesson consisted of finding patterns of divisibility of multiple digit numbers without employing long division. The first scenario consisted of students finding multiple digit numbers that would be divisible by

37. Students were asked to develop and test possible equations. Since the main focus was not the actual calculation of long division, students were allowed to use a spreadsheet program to distribute equations. Afterwards, students were asked to generalize and draw conclusions about their results.

Manoucheheri (1997), provided students with the necessary tools for building higher order level skills. Again, technology served as a bridge or tool to accessing and employing the higher thinking skill descriptors, such as analysis, synthesis, and evaluation. Like Niess (1993), Manoucheheri (1997) did not provide an assessment component for the students either. This is imperative to know that all students are learning and developing higher order level thinking skills.

Another example of the use of technology to help develop higher order thinking skills is through the use of computer programming. As technology constantly changes, the main focus should be on how technology will assist students in learning. The following article, though from over a decade ago, provides a perspective into how higher order thinking skills are achieved. In the late 1980's, there was a proliferation of educational computer programs aimed to help students build necessary skills. Many of these programs fell short of helping to develop higher level thinking skills. One program that came from this era was the LOGO program, which was a type of computer language geared for the middle and high school students.

This program was multi-faceted and provided students with opportunities for experimentation and exploration. With LOGO, students created micro-worlds, which incorporated geometry and algebra. LOGO could be viewed as a vehicle for the development of higher order thinking skills (Dunne, 1991). Some of the descriptors of higher thinking skills present in the application of this program included judging and interpretation, arriving at multiple solutions, allowing for self-regulation, and synthesizing and analyzing information.

At one point in time, the actual LOGO program was offered as a class in middle and high school. LOGO, however, was not considered user friendly and many teachers felt it was overwhelming and time consuming (Dunne, 1991). In retrospect, technology itself should not detract time off the general curriculum, but rather, enhance learning in the subject areas and help develop higher order thinking skills.

The usefulness of technology has never been more important in the development of writing than in recent times. In the following research study, Sinatra (1994) conducted a study using technology as a tool to develop higher level thinking skills in the area of writing and reading. The research pool consisted of 260 at-risk fourth graders from various schools. These students would take part in a program that called for incorporation of instructional strategies, such as modeled writing and guided practice, with the use of technology, to build semantic maps and brainstorming techniques. This allowed students to organize their ideas and develop their writing, through continuous modeling. The results of the study indicated positive and substantial gains in their development of not only their writing skills, but also in the development of higher order thinking skills.

Sinatra (1994) provided a clear methodology that outlined clear objectives and assessment tools. The target sample was substantially large, which was indicative of the reliability of the findings. Sinatra

(1994) also noted that the students in the study exhibited better attitudes towards school and their schoolwork. This was measured through student questionnaires before and after the program. Although there were no writing samples collected, the students' writing was graded on the prescribed rubric. Even though some of the students made a positive gain of at least one grade point in their rubric writing scores, minimal mention was given to explain gains in the development of higher order thinking skills. Nevertheless, there was a significant correlation between the use of technology and developing higher order thinking skills.

Hypothesis

The research question of this thesis was whether a difference existed between teachers' perceptions about using the computer lab in aiding the development of higher order thinking skills and the actual computer lab practices. Since this study was a descriptive research study, information was collected only to compare the perceptions of teachers regarding the computer lab and the actual lab activities. There was no effort in providing statistical significance of this relationship, but rather only to see if there was a difference between the two. Though no definite conclusions could be drawn regarding such a relationship based on this study, a hypothesis of the possible results was necessary to establish a foundation for the study.

After posing the research question, and before the collection of data, a hypothesis was made regarding the possible outcomes of the descriptive study. The initial hypothesis of this study was that there would not be a difference between teachers' perceptions and actual computer lab activities. The teachers would indicate, from the survey (Appendix B) that they believed their computer lab practices would aid in developing higher order thinking skills. Furthermore, the encoding process of the actual computer lab activities would indicate that higher levels of thinking, or Bloom's Taxonomy levels of analysis, synthesis, and evaluation, were in fact being practiced.

CHAPTER THREE

METHODOLOGY

Introduction

As an overview, this descriptive research study was aimed at finding the difference between teacher perceptions about using the computer lab as a tool in developing higher order level thinking skills and actual computer lab practices. In this study, 58 percent of the elementary school staff participated in a survey regarding their perceptions about the computer lab use (Appendix B). This included scaled questions regarding how the lab was used and the development of higher order thinking skills.

Furthermore, a daily log was maintained in the computer lab to chart the types of activities teachers used with their students. This log was maintained for an entire school year, and the information was categorized by grade level, track, and type of activity. Moreover, the researcher used Bloom's Taxonomy descriptors to quantify the level of thinking present in each lab activity (Appendix A). Each type of lab activity was carefully studied to provide adequate description. Consequently, this aided in the encoding process.

Instrumentation

Teacher Survey

The method of collecting data from teachers was conducted through a survey (Appendix B). This survey contained five scaled questions, not only regarding the teachers' computer lab practices, but also their perceptions about using the computer lab as a tool for developing higher order level thinking skills. There was also a section in the survey where teachers were able to indicate their computer knowledge. This section was scaled to indicate high, medium, and low responses. Aside from the scaled questions, there was a section for teachers to write additional comments and suggestions.

Lab

Out of the 29 teachers employed at this elementary site, only 21 of them were on track, or scheduled for work that month, when the survey was distributed. Furthermore, the number of teachers that turned in a survey from this group was 17, or 58 percent of the total population. This sample included teachers from all grade levels in both primary and upper grades. Of the 17 collected, two of the surveys were dismissed as not all of the scaled questions were completed. Nevertheless, the number of surveys turned in by the teachers was a sufficient representation of the staff.

Computer Lab Inventory Log

As the focus of the research question dealt with teacher perceptions concerning computer lab use in developing higher order level thinking skills and the actual computer lab use practices, it was imperative to maintain a log to make an inventory of the lab activities conducted by the teachers. This inventory log of lab activities was maintained for an entire school year in which the computer lab aide would write a brief description of each activity and computer program used by each classroom. This description was maintained for every visit to the computer lab made by all the teachers of the school. In this log, grade, teacher, and track were also included. The data obtained from this log at the end of the school year was then analyzed.

Design

After a review of all the types of lab activities charted in the log, which ranged from word processing to the development of hyperstudio projects and internet research, a process to quantify and describe the level of higher order thinking associated with each activity was used. This was accomplished through the use of Bloom's Taxonomy descriptors of the levels of higher order thinking (Appendix A).

Using this instrument, each lab activity was categorized under a specific level of thinking, whether being the lower levels of knowledge and comprehension to the higher levels of analysis and synthesis. While reviewing each lab activity, descriptors relating to its use were identified. For example, the descriptors identified with the activity of word processing were mainly characteristic of Bloom's Taxonomy second level of thinking, or comprehension (Appendix A). For the purposes of this study, the results of this analysis was then compared to the data collected from the surveys (Appendix C) in order to answer the research question.

Data Collection

The data collection for the computer lab activities was set for an entire school year. There was a total of 1,320 lab activities recorded during this time period. The inventory log was divided by teacher and grade level. Each section listed all of the computer lab activities and the computer programs used for every lab visit by each class. For the most part, a brief description regarding the lab activities was also included. All of the activities were logged in date order, beginning in July 2000 and ending in June of the following year, 2001.

The perceptions of teachers were collected through the use of a survey (Appendix B). The survey was administered during the beginning of the year. Teachers were given a period of two weeks to complete the survey. Over 51 percent of the 29 teachers on staff returned a completed survey. A second survey was not necessary since the long term perceptions of teachers was not an area under focus in this study.

Data Analysis

Once the collection of data was complete, the process of encoding the data began. This means of placing a numeric value to each la activity and each of the survey responses was necessary before any analysis of the data could take place. Numeric values corresponded to a thinking level from Bloom's Taxonomy.

This numeric value was derived from a careful study of the descriptors or action verbs characterizing a particular lab activity. For instance, one common lab activity was a math drill and practice program. In this program, students were asked to recall math facts from their prior knowledge. Upon review of the computer lab activity, most of the descriptors identified this activity as a level one from Bloom's Taxonomy. Thus, each occurrence of this particular activity was encoded with a numeric value of one, representing the first thinking level in Bloom's Taxonomy.

Some lab activities contained descriptors for two levels of thinking. For example, a simulation program contained descriptors for both comprehension and application levels of thinking. In a situation like this, the level of thinking containing the higher number of descriptors was chosen, and thus encoded with the numeric value of that level of thinking. Moreover, there were six activities out of 1,326 total activities that were unidentifiable and consequently not included as part of this study.

Results

Once the encoding process was complete, the data analysis of the 1,320 lab activities proved to be insightful (Appendix C). There were 507 activities, or 38.4 percent, at the knowledge level, or the lowest level of thinking from Bloom's Taxonomy. There were 296 activities, or 22.4 percent, at the comprehension level, or the second level of thinking. There were 331 lab activities, or 25.1 percent, classified at the application level, or the third level of thinking. In total, there were 1,134 of the total 1,320 activities characteristic of the lower levels of thinking. That constituted approximately 86 percent of the activities descriptive of lower levels of thinking.

This gap was more evident at the primary grade levels (Table 1). The primary grades accounted for 909 total lab activities. Of these, 882 activities were characteristic of the lower levels of thinking. That accounted for more than 90 percent of all lab activities at the primary grades. There were only 87 activities

Table 1. Primary Grades

Thinking Level	I	II	III	IV	V	VI
Percent	46%	21%	24%	10%	0%	0%
Number of Activities	416	192	214	87	0	0

classified at the thinking level of analysis, and no activities at the synthesis and evaluation levels. Thus, less than 10 percent of the lab activities at the primary grades addressed higher order thinking.

Though the results at the upper grade levels were more positive, a gap between higher and lower level thinking was still evident (Table 2). The upper grades had a total of 411 lab activities throughout the entire school year. There were 312 activities, accounting for 75 percent, that were classified at the lower levels of thinking. Conversely, there were 79 activities at the analysis level and 20 at the synthesis level. This accounted for 24 percent of the lab activities addressing higher order thinking.

Table 2. Upper Grades

Thinking Level	I	II	III	IV	V	VI
Percent	22%	25%	28%	19%	5%	0%
Number of Activities	91	104	117	79	20	0

The results of the survey also provided useful data (Appendix D). As far as one of the survey questions regarding perceptions of the computer lab, 80 percent of the participants agreed or strongly agreed that use of the computer lab was helping their students develop higher order thinking skills. Moreover, 13 percent indicated that they often used the internet to conduct research for class projects. Approximately 86 percent of the teachers surveyed indicated that they seldom or never use the computer lab for word processing activities. About 67 percent of those surveyed classified their computer knowledge as adequate, 13 percent as low, and 20 percent as high (Table 3).

Table 3. Teacher Computer Knowledge

Computer Knowledge	High	Medium	Low
Percent	20%	67%	13%
Number of Teachers	3	10	2

Discussion

The results of the study indicate that a substantial gap exists between the number of lab activities that address lower and higher order thinking levels. Over 86 percent of the lab activities, during the entire school year were descriptive of Bloom's Taxonomy lower levels of thinking. Though the gap was more evident at the primary grades, there was also a substantial gap in the upper grades. No activities addressed the evaluation level, or the highest thinking level from Bloom's Taxonomy. In general, the majority of the lab activities dealt with knowledge recall and comprehension or prescribed information. Over 60 percent of the 1,320 total activities were characterized at the knowledge and comprehension levels of thinking.

The perceptions of the teachers indicated an opposite picture of the data results. Teachers were more inclined to perceive that the use of the computer lab helped their students develop higher order thinking skills. This amount, over 80 percent, was conversely the same as the total percentage of activities descriptive of lower levels of thinking.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The results of the study provides an answer to the research question. The researcher asked whether a difference existed between the teachers' perceptions of using the computer lab as a tool in developing higher order thinking skills and the actual computer lab practices. The prediction of the results of this study was that there would be no substantial difference between the two areas of focus. According to the results of the study, there was a substantial difference between the teachers' perceptions and their actual computer lab practices addressing higher order thinking.

Since this was a descriptive or comparative study only, there were no statistical analyses made to measure validity of the results nor reliability. The results are only indicative that a difference was present between the two areas of focus, and thus no effort to prove correlation or causation was made. Nevertheless, further quantitative studies are recommended to research the use the computer lab as a tool to develop higher order thinking skills. This can be accomplished through longitudinal studies using a control group and with pre and posttests.

Recommendations

The proliferation of educational computer programs has never been as prevalent than at the present time, providing for new and enhanced computer packages. Also, telecommunications has sprouted since the inception of the internet for instructional purposes. With all these tools, it is easy for teachers to feel overwhelmed and uncomfortable in using technology as a tool to develop higher order thinking skills. Thus, it is imperative for teachers to always apply the necessary criteria when choosing new computer software to ensure that its substantive value can aid in the development of these skills. Teachers should apply thinking model descriptors, as those found in Bloom's Taxonomy, to ensure student growth, especially in the higher order thinking levels of analysis, synthesis, and evaluation.

As noted before, technology should not be viewed as an end, but rather as a means. Technology should serve as a tool to aid students in developing higher order thinking skills. The use of the computer lab in more innovating and new ways can help students develop these skills.

APPENDIX A

BLOOM'S TAXONOMY

Bloom's Taxonomy

Levels of Thinking	General Descriptors
I. Knowledge	recognize, recall, list, label, select, define, describe, outline, match, select, recite, state, reproduce, restate
II. Comprehension	understanding, state in own words, defend, explain, predict, summarize, generalize, matching, listing, conclude which, give reasons, summarize
III. Application	use, solve, compute, develop, perform, organize, demonstrate, modify
IV. Analysis	breaking down into parts, finding relationships, infer, outline, distinguish, diagram, compare, contrast, fact v. opinion
V. Synthesis	compose, design, create, make
VI. Evaluation	judge, rate, weigh, appraise, justify, provide arguments to support

Adapted from Bloom et al. (1956)

APPENDIX B

TEACHER SURVEY

TEACHER SURVEY

Instructions: Please read the following statements regarding computer lab use. Mark an "X" to the number that most likely describes your position, from 1 (never, not agree) to 4 (frequently, strongly agree).

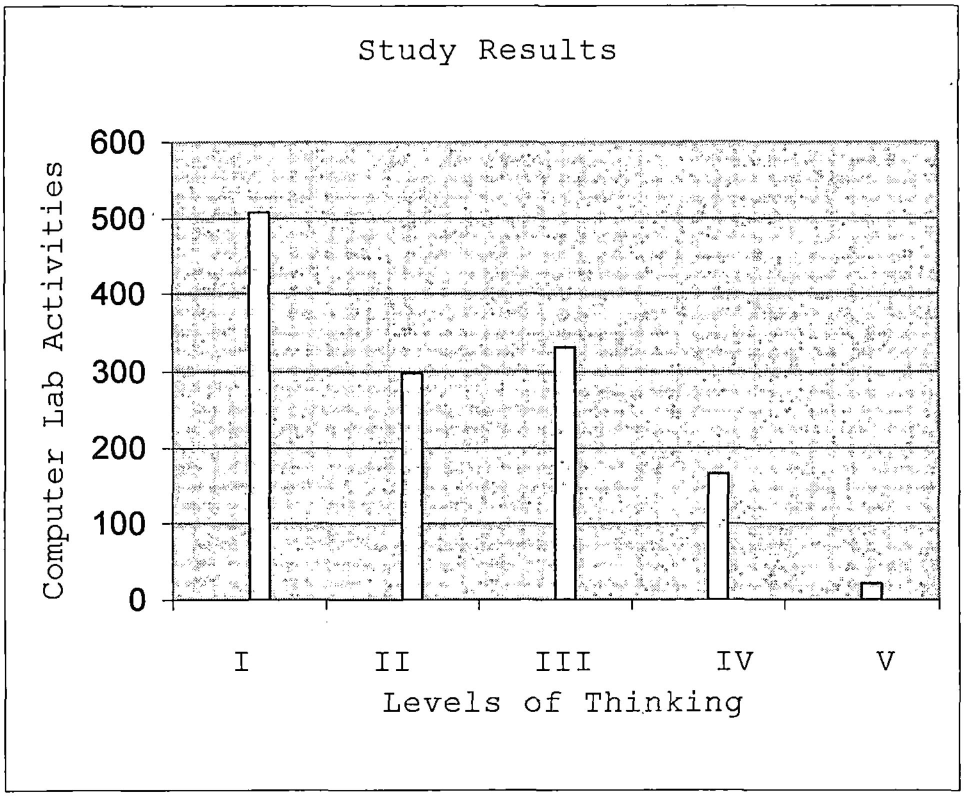
Statements:	1 never/ not agree	2 seldom/ partly agree	3 often/ agree	4 frequently (strongly agree)
1. I mainly use the computer lab to conduct word processing activities.				
2. I use the computer lab to provide my students the opportunity to conduct research on the internet.				
3. I think that using a computer lab helps develop my students' higher order level thinking skills.				
4. I think the computer lab does not adequately address higher order thinking skills development.				
5. I would be interested in learning how to conduct more activities in the computer lab to develop higher order thinking skills.				

I teach _______ grade.

I would grade my computer knowledge as: (circle one) high, medium, low

APPENDIX C

STUDY RESULTS


Study Results
Computer Lab Activities
600
500
400
300
200
100
0
I
II
III
IV
V
Levels of Thinking

N = 1,320

APPENDIX D

SURVEY RESULTS

Survey Results

Statements:	1 never/ not agree	2 seldom/ partly agree	3 often/ agree	4 frequently (strongly agree)
1. I mainly use the computer lab to conduct word processing activities	7%	80%	13%	0%
2. I use the computer lab to provide my students the opportunity to conduct research on the internet.	60%	27%	13%	0%
3. I think that using the computer lab helps develop my students' higher order level thinking skills.	0%	20%	40%	40%
4. I think the computer lab does not adequately address higher order thinking skills development.	33%	40%	20%	0%
5. I would be interested in learning how to conduct more activities in the computer lab to develop higher order thinking skills.	7%	7%	40%	47%

N = 29
n =15

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